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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to an Electric Motor-Driven Linear Displacing Device

We, HELMUT KORTHAUS, of 3, Fernblick, Wuppertal-Barmen, Germany, and RICHARD WILKE, of 11, Eschfeldstrasse, Gelsenkirchen-Buer, Germany, both German Citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an electric motor-driven linear displacing device. Such a device may be used for example to operate doors, flaps and other displaceable mechanisms.

In connection with displacing devices operable by power means there is a requirement that in case of danger, for example, in the event of failure of power supply to the device, the mechanism being displaced must return to the initial position again. Thus, for example, an air door in underground mining must be capable of opening or closing automatically should there be a breakdown of the mine ventilator, or again, a brake must be engaged if the driving power for a machine fails, or even the doors of a bank must close automatically if there is a failure of the electrical supply in the bank.

In all the above-mentioned cases, when the displacing device is operated by compressed air or pressure oil or some other fluid, that is to say by means of cylinders and pistons, the automatic return to the initial position is ensured *per se*, since in the absence of pressure of the operating air or liquid, the piston is released.

Electromagnetically operated displacing devices have become known which likewise release the operated mechanism in the event of an electric current failure so that the operated mechanism closes, for example. Since, however, the force of attraction of an electromagnet on an iron armature drops considerably as the distance between the two increases, only short travels are possible. There is, moreover, often a disadvantage in the abrupt attraction and release of the armature.

It is an object of the present invention to provide a linear displacing device driven by an electric motor for the described applications which, without the use of an intermediate medium such as compressed air or pressure oil and dispensing with the compressor which is otherwise necessary for this purpose, operates purely electrically without having the disadvantages of the electromagnetically operated displacing devices.

The electric motor-driven linear displacing device of the present invention accordingly comprises an internally threaded axial tubular shaft section fast with the motor rotor and a coacting elongated threaded operating rod extending through said tubular shaft section and secured against rotation but axially displaceable on rotation of said shaft, and an electromagnetically operable brake for the rotor actuated when the elongated rod reaches a limiting position, wherein the elongated rod is returned by the action of a load or of a spring or springs to its initial position on failure of the motor and brake current.

Advantageously, both the rod and the tubular shaft section are ball-threaded at least over part of their respective lengths and coact through the medium of a train of recirculating ball bearings.

Moreover, a further axial tubular shaft section advantageously extends an end of the motor rotor, the electromagnetically operable brake being located around said further tubular shaft section, said brake comprising a brake disc having a brake lining and co-operating with a radially extending flange, likewise having a brake lining, fast on the tubular shaft section.

The motor casing may have an axial extension in which is provided a polygonal guide

engaged by a correspondingly polygonal part of the operating rod whereby said operating rod is secured against rotation. Alternatively, for securing the operating rod against rotation, a key is provided which is a sliding fit in a longitudinally extending groove provided in the operating rod at the unthreaded part thereof.

The springs may be tension and/or compression springs and act on an end region of the operating rod and effect movement of the rod backward or forward into the initial position when the brake is off and the current supply to the motor fails. The end of the operating rod may have a collar one side of which is engaged by a spring acting between the collar and the motor casing and the other side of which is engaged by a spring acting between the collar and an end wall of a protective cap enclosing the collar and springs. Limit switch contacts may be arranged in the protective cap, the contacts being operable by a cam provided on the end collar of the operating rod and serving to de-energise the motor when the operating rod has been moved to the desired extent in either of its directions of movement.

The fact that the switching contacts are also disposed in the protective cap and cooperate with the cam therein is a decided structural advantage.

Now, if some risk arises in a displacing device according to this invention, for example the electric current fails at the moment when the operating rod is just opening a flap at the outlet of a bunker, then on the one hand current supply to the motor is interrupted and on the other hand the brake is off so that e.g. the springs, can take effect and move the operating rod back in an axial direction until the safety position, that is to say the starting position of the rod, is reached, that is to say the flap is closed again. The friction of the ball thread is so small that restoration is possible very quickly.

In order to make the invention clearly understood, reference will now be made to the accompanying drawing which is given by way of example and in which a linear displacing device driven by an electric motor is illustrated.

The electric motor has a stator 2 and a stator winding 3 and is disposed in a casing 1. When the stator winding is connected to a source of current a rotor 4 of the motor is caused to rotate. The motor can be a three-phase, single-phase current, universal, or direct current motor, and accordingly, brushes 5 and a commutator 6 which may be required for the various possible embodiments have been shown in the drawing. In a three-phase motor these parts can be dispensed with.

Near its periphery, the rotor 4 has longitudinally extending bores by means of which two tubular shaft sections 8 and 9 are flanged-on to the rotor 14 so as to be rigid and concentric therewith, by means of bolts 7. Centring of the flanged-on shaft sections 8 and 9 is also effected by means of the short-circuit rings 10 on both ends of the rotor, these rings being turned true-to-size on the inside. The tubular shaft section 8 has an internal ball thread which has a frictional action substantially less than normal threads because ball bearings 11 are used for effecting engagement between the ball thread and a counter thread. The counter thread is formed by the thread of an operating rod 12 which has a forked head 13 at its upper end. Provided the operating rod 12 is secured against rotation, the rod will shift backwards or forward according to the direction of rotation of the rotor when the motor is switched on.

The rod 12 is provided with a longitudinal groove—not shown—which when engaged by a guide key disposed in the part 14 for example prevents rotation of the rod 12 and thereby ensures the backward and forward motion. Alternatively, the lower end of the rod 12, which extends into a protective cap 15, has a non-circular cross-section, for example square, and a corresponding guideway is provided in the cap 15. This has been found advantageous since the rod 12 at its other end, can, owing to the absence of the longitudinal groove, be more easily sealed-off relative to the casing 1 at the point 14, in order to prevent dirt from entering the casing 1.

On the lower end of the rotor 4 as viewed in the drawing, the flanged-on tubular shaft section 9 has a radial flange 16 which serves as the brake disc of an electromagnetically operated friction brake. The brake comprises a magnetising winding 17 in an iron ring 18 which is rigidly fixed in the motor casing 1. The iron ring accommodates a roller bearing 19 in its interior just as, at the other end of the casing 1, a part of the casing or an annular land 20 connected with the casing 1, accommodates a roller bearing 21. These two roller bearings 19 and 21 thus constitute the actual mounting of the rotor. Two thrust bearings 22 and 23 serve to convey the pressure from the motion of the rod 12 to the casing 1.

At one and the other radial face of the iron ring 18 two discs 24 and 25 are disposed which are interconnected by means of bolts 26 uniformly angularly distributed. Situated on each bolt 26 is a compression spring 27 which, when the winding 17 is not energised, by abutting against the bottom of a recess in the iron ring 18, holds the two interconnected discs 24 and 25 in the position shown in the drawing. Thus the brake, consisting of the flange 16 and the disc 24, each of which has a brake lining 28, is off. The flange 16 can thus rotate freely and the rod 12 moves in the direction corresponding to the rotation until a cam 29 on a collar 34 of the rod 12

operates either a limit switch 30 or 31, both of which are situated in the cap 15, so as to cut off the supply of current to the motor by way of the motor relay. At the same moment, through normally closed contacts of the releasing relay, the ring magnet winding 17 is connected to the phase voltage of the motor through a rectifer. The winding 17 is therefore energised and the disc 25 is attracted to the iron ring 18 thereby closing the disc 24 onto the flange 16 so that, through the fixed rotor and the ball-thread, the rod 12 is likewise held fixed in its position.

A weight which for example is being lifted by means of the rod 12, will thus remain in the lifted position. For this, all that is necessary is that the braking force of the brake linings 28, governed by the adhesive force of the electromagnet 17, 18 is at least as great as the maximum motor torque which is required to lift the weight.

It is obvious that by reversing the polarity of the motor and switching in the relay again, the magnet is de-energised and the motor runs in the opposite direction, so that the weight is lowered, for example, until once again the corresponding limit switch either 30 or 31, comes into operation. It is also possible to lower the raised load without reversing the polarity of the motor, simply be de-energising the winding 17. In this case the brake comes off and the weight sets in rotation the rotor 4 which is not energised, because the recirculating ball bearing, owing to its very low friction losses, converts the force of the weight—acting in the longitudinal direction of the rod 12 —into a rotary motion, with only very little loss of energy, through the ball-thread, and the force of the weight is dissipated in the work of accelerating the rotor 4.

From the foregoing, it will be clear that the actual purpose of the invention is also achieved; for in the event of failure of the supply of electrical energy the electromagnet 17, 18 is de-energised and the brake linings 28 are released through the action of the springs 27, so that, for example, the raised weight is thereby returned to the position of rest. In cases where the weight has to be moved horizontally and not vertically and in cases where practically no weight has to be moved but rather there is only a shifting of quite small masses, the return of the rod 12 to the starting, or safety position is effected by built-in springs 32 and 33. These springs, of which only one of the two need be installed according to the effect required, pull or push the rod 12 back into the starting or safety position if there is a complete failure of current, as a consequence of the release of the brake lining 28, because—as has been said already—the recirculating ball bearings have no friction worth mentioning.

Instead of effecting the switching off of the motor by means of the limit switches 30 and 31 acting through a relay, it is also possible, chiefly with low power motors, to use these switches 30 and 31, for example in the form of micro-switches of high switching capacity, directly for switching the motor off and on again. This makes it possible for the whole device to be of compact construction and thus suitable for the operation of door locks. There are many varied fields of application since recirculating ball bearing assemblies and ball threads can be produced with very small dimensions. It is also also conceivable to install potentiometers in the cap 15, in addition to the switches 30 and 31, so that the position of the rod 12, acting through a sliding contact attached thereto, makes a remote indication possible and even an automatic regulation of the desired intermediate position of the rod. In this way it is possible, for example, to regulate a brake pressure to a constant value.

WHAT WE CLAIM IS:—

1. An electric motor-driven linear displacing device comprising an internally threaded axial tubular shaft section fast with the motor rotor and a coacting elongated threaded operating rod extending through said tubular shaft section and secured against rotation but axially displaceable on rotation of said shaft section, and an electromagnetically operable brake for the rotor actuated when the elongated operating rod reaches a limiting position, wherein the elongated operating rod is returned by the action of a load or of a spring or springs to its initial position on failure of the motor and brake current.

2. Electric motor-driven linear displacing device as claimed in Claim 1, in which the operating rod is ball-threaded and coacts with the internally ball-threaded tubular shaft section through the medium of a train of recirculating ball bearings.

3. Electric motor-driven linear displacing device as claimed in Claim 1 or 2, in which a further axial tubular shaft section extends an end of the motor rotor, the electromagnetically operable brake being located around the latter tubular shaft section, the brake comprising a brake disc having a brake lining and co-operating with a radially extending flange, likewise having a brake lining, fast on the tubular shaft section.

4. Electric motor-driven linear displacing device as claimed in Claim 1, wherein the motor casing has an axial extension in which is provided a polygonal guide engaged by a correspondingly polygonal part of the elongated operating rod, whereby said operating rod is secured against rotation.

5. Electric motor-driven linear displacing device as claimed in Claim 1, wherein for securing the elongated operating rod against rotation, a key is provided which is a sliding fit in a longitudinally extending groove pro-

vided in an unthreaded portion of the operating rod.

6. Electric motor-driven linear displacing device as claimed in Claim 1, wherein the end of the operating rod has a collar, one side of which is engaged by a spring acting between the collar and the motor casing and the other side of which is engaged by a spring acting between the collar and an end wall of a protective cap enclosing the collar and springs.

7. Electric motor-driven linear displacing device as claimed in Claim 6, wherein limit switch contacts are arranged in the protective cap, the contacts being operable by a cam provided on the collar of the operating rod, and serving to de-energise the motor when the operating rod has been moved to the desired extent in either of its directions of movement.

8. Electric motor-driven linear displacing device as claimed in Claim 6 or 7, wherein a longitudinally extending potentiometer is disposed in the protective cap adjacent to the end of the operating rod, a sliding contact of the potentiometer being mounted on the end of said operating rod.

9. The electric motor-driven linear displacing device, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale